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MODERNIZATION SOLUTIONS FOR LOCAL ROADS

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Abstract: *The paper presents a solution to upgrade the local roads in the Moldavia region, using rigid road structures. For the cement concrete road it had been used local pit gravel partially crushed which replaced a part of the career aggregates. There are analyzed the characteristics of aggregates used in the preparation of cement concrete road and road structures behavior in time under the influence of the climatic factors and road traffic.*

Key words: *cement concrete road, local materials, tensile flexure strength, tensile splitting strength, compression strength, concrete unit weight.*

1. Introduction

Political and economic restructuring in Eastern Europe in the last 25 years has led to substantial changes in the transportation system.

European transport policy objective is to establish a balance between economic development and quality requirements and traffic safety in order to develop a modern transport system.

In European Union, the balance tends towards a transport system centered on road transport.

In Romania, one of the specific objectives in road transport, besides rehabilitation and modernization of national transport infrastructure, is the integration of the local roads in the national infrastructure network [1].

In addition, considering that over 50% of the total length of Romanian roads are the local roads that are not upgraded, a solution that can be used in the Moldavia region is the rigid road structures.

2. Natural pit gravel partially crushed

The natural pit aggregates partially crushed used for the presented local roads are from a pit of Suceava River in Milişăuţi, jud.Suceava. These aggregates are siliceous aggregates that have the following mineralogical composition (determined by X-ray analysis): Quartz - 95%, feldspar plagioclase 3...5% and traces below 1% of serine, limonite, pyrite, lodestone, and kaolinite.

Romanian norm [7] requires in the case of a single layer of concrete cement road the using of minimum two varieties of 8-16 mm and 16-25 mm chippings. In the preparation and realization of cement concrete road with local materials both mandatory chipping varieties were replaced with partially crushed pit gravel 8-16 mm and 16-25 mm.

The characteristics of the aggregates used in the preparation of cement concrete for road are shown in Table 1. Also, Fig. 1 shows the grain size distribution curves of

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the aggregates used, the granulometric distribution and the range size of the aggregate mixture used to prepare the BcR 4.0 cement concrete for road.

Characteristics of the Milişăuţi pit aggregates Table 1

Nr.	Characteristics	UM	Obtain values					Admissible limits [7]
			Natural sand	Pit aggregates partially crushed				
			0-4	0-4	4-8	8-16	16-25	
1.	Sand equivalent	%	98	96	-	-	-	Min.85
2.	Activity coefficient	%	-	1	-	-	-	Max.1.5
3.	Degree of chipping	%	-	-	89	85	91	Min. 65
4.	Shape coefficient	%	-	-	24	16	16	Max. 25
5.	Crushing resistance of aggregates in saturated state	%	-	-	61	76	70	Min. 60
6.	Freeze-thaw resistance / weight loss	%	-	-	1.2	1.0	0.9	Max. 10
7.	Wear with car Los Angeles	%	-		21	-	-	Max. 35
					-	19	-	Max. 30
					-	-	15	Max. 25

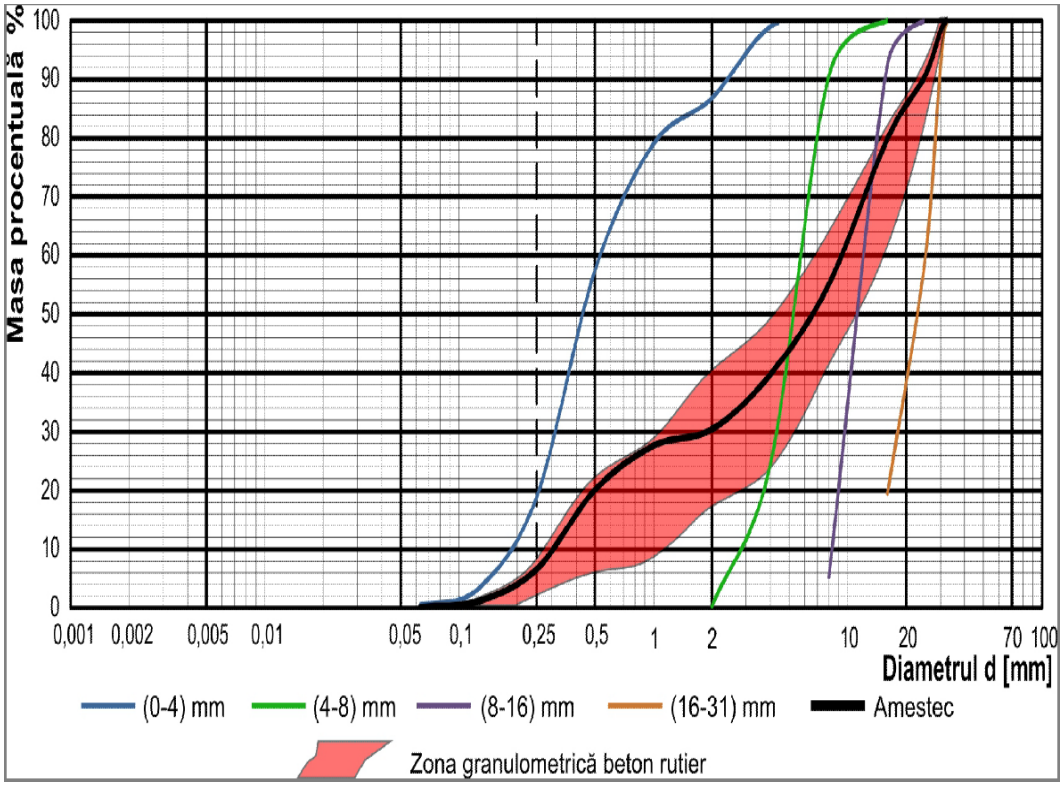

Fig. 1. *Grain-zise distribution curve for the aggregates and for the aggregates mixture*

3. Cement concrete for roads made with pit aggregates

In Romanian norms [7] the Cement Concrete Road notation is BcR 4.0.

The dosage of cement type I 42.5 R was 350 kg/m, the ratio A/C = 0.45, additive dosage of CEMENTOL SPA 94 was 3 ml/kg of cement, resulting a density of the designed concrete of 2358 kg/m³.

The presented road is a municipal two-traffic lane road in town Voitinel located in Suceava County and it was conducted in autumn 2011 with the following composition of the road structure:

- Layer form - the existing pavement with a thickness of 15 cm;
- Foundation layer ballast 0-63 cm - thickness 25cm;
- Stabilized sand + Kraft paper - 2 cm;
- Cement Concrete BcR 4.0 - 20 cm thick.

The physic-mechanical properties of hardened concrete at the age 28 days, RC (compression strength on cubes 150x150x150 mm), Rti (tensile flexure strength on prisms 150x150x600 mm and at the age of 3 years (1,095 days)), RC (compression strength on cores with diameter of 100 mm) and Rtd (tensile splitting strength on cores with a diameter of 100 mm), are shown in table 2.

Physico-mechanical properties of cement concrete BcR 4.0 Table 2

	R_C(N/mm²)		R_{ti}(N/mm²)	R_{td}(N/mm²)	**Admisible limits [7]**
Age	**28 days**	**1095 days**	**28 days**	**1095 days**	
Number of samples	72	4	32	4	-
γ_{bet} (kg/m³)	2358	2376	2358	2319	2390±30
Obtain values	35.38	34.88	4.10	3.26	R_C=35
*S(N/mm²)	0.96	1.89	0.107	0.175	R_{ti}=4.0
**C_V(%)	2.71	5.42	2.61	5.38	

*S – standard deviation
** C_V – coefficient of variation

Figure 2 shows the variation in time of RC (N/mm2) and the variation of Rt (N/mm2). The ratio RTD / Rti = 0.795 is between the values Walker and Bloem (0.62 ... 0.90) and Efsen and Glarbo (0.67 ... 0.91) as [3].

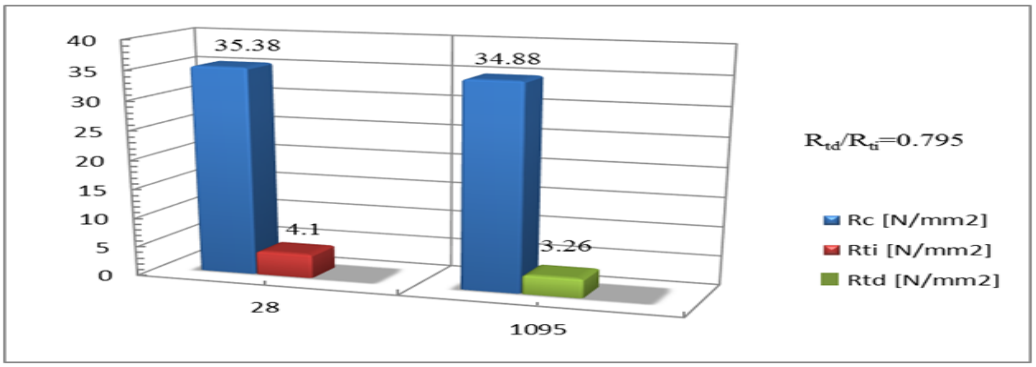

Fig. 2. *Variation in time of the mechanical resistance*

4. Cement concrete road degradation status

The status of degradation is characterized by the degradation index: (ID) as in [6] and determined with the relation (1).

$$ID = \frac{number\ of\ damaged\ road\ panel}{D_1 + 0,5 \cdot D_2 + 0,5 \cdot D_3 \cdot N / S + 0,3 \cdot D_4} \quad (1)$$

Where:

N- number of road panel per lane;

S - measured surface on a lane (m^2);

D_1 - number of settled road panels;

D_2- number of the patching and cracking road panels;

D_3- the surface of the affected area: cracks, corner cracks and longitudinal irregular shape cracks;

D_4 - exfoliated surface.

Degradation index was determined on three homogeneous sectors and the results are shown in Table 3.

The resulting degradation index as presented in [6] is very good, and the only problems on the entire length of the road are:

- Exfoliation of the surface (fig.3)
- Transverse cracks (fig.4).

Degradation Index Table 3

Homogeneous sectors	**ID**
Km 0+150-0+230 dr.	0.94
Km 1+400-1+490 stg.	0.83
Km 2+000-2+080 dr.	1.04
Mean value	0.94
S	0.085
C_v (%)	9.15

Fig. 3. *Exfoliation of the surface*

Fig. 4. *Transverse cracks*

4. Conclusions

The use of the rigid cement concrete made of pit partially crushed aggregate for road structures is a viable and economical solution, cheaper by approx. 30% than concrete made with cement road chippings as presented in [7] for upgrading the local roads. The structures made of cement concrete road have an appropriate behavior after 3 years from commissioning.

Road structures with cement concrete made of pit aggregates partially crushed will be monitored annually. It will be analyzed the behavior over time, and if it will be appropriate will be arranged to introduce in the design norms these types of structures.

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